

AD-A054 035

FRANK J SEILER RESEARCH LAB UNITED STATES AIR FORCE --ETC F/G 1/5
A SURVEY OF LEAD LEVELS IN SOILS AND VEGETATION OF SELECTED AIR--ETC(U)
OCT 77 C E THALKEN, A L YOUNG, M J MORAN
FJSRL-TR-77-0011

UNCLASSIFIED

NL

1 OF 1
ADA
054035



END
DATE
FILMED
6-78
DDC

AD A 054035



AD No. _____
DDC FILE COPY



OR FURTHER TRAN

FRANK J. SEILER RESEARCH LABORATORY

FJSRL TECHNICAL REPORT -77-0011

11 OCTOBER 1977

12 23p.

6 A SURVEY OF LEAD LEVELS IN SOILS
AND VEGETATION OF SELECTED AIRFIELD
ENVIRONMENTS.

9 Technical Summary rept.

10 CHARLES E. THALKEN,
ALVIN L. YOUNG,
MICHAEL J. MORAN
LAWRENCE R. KLINESTIVER

14 FJSRL-TR-77-0011

16 PROJECT 2303

17 F1

DDC

RECEIVED
MAY 19 1978

APPROVED FOR PUBLIC RELEASE;
DISTRIBUTION UNLIMITED.

AIR FORCE SYSTEMS COMMAND

UNITED STATES AIR FORCE

319 920

JOB

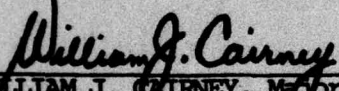
This document was prepared by the Faculty Research Division, Directorate of Chemical Sciences, Frank J. Seiler Research Laboratory, United States Air Force Academy, Colorado. The research was conducted under Project Work Unit Number 2303-F1-76, Lead as an Indicator of Environmental Quality in Airport Environs. Major Charles E. Thalken was the Project Scientist in charge of the work.

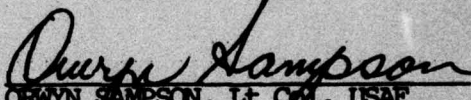
When US Government drawings, specifications or other data are used for any purpose other than a definitely related Government procurement operation, the Government thereby incurs no responsibility nor any obligation whatsoever, and the fact that the Government may have formulated, furnished or in any way supplied the said drawings, specifications or other data is not to be regarded by implication or otherwise, as in any manner licensing the holder or any other person or corporation or conveying any rights or permission to manufacture, use or sell any patented invention that may in any way be related thereto.

Inquiries concerning the technical content of this document should be addressed to the Frank J. Seiler Research Laboratory (AFSC), FJSRL/NC, USAF Academy, Colorado 80840. Phone AC 303, 472-2665.

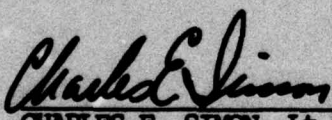
This report has been reviewed by the Chief Scientist and is releasable to the National Technical Information Service (NTIS). At NTIS it will be available to the general public, including foreign nations.

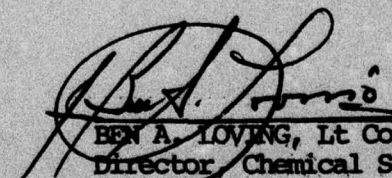
This technical report has been reviewed and is approved for publication.


WILLIAM J. CAIRNEY, Major, USAF, BSC
Technical Advisor for Research
Department of Chemistry and
Biological Sciences


ORWYN SAMPSON, Lt Col, USAF
Director of Research
Director of Chemistry and
Biological Sciences

FOR THE COMMANDER


CHARLES E. SIMON, Lt Col, USAF
Chief Scientist


BEN A. LOVING, Lt Col, USAF
Director, Chemical Sciences

Copies of this report should not be returned unless return is required by security considerations, contractual obligations, or notice on a specific document.

Printed in the United States of America. Qualified requestors may obtain additional copies from the Defense Documentation Center. All others should apply to: National Technical Information Service
5285 Port Royal Road
Springfield, Virginia 22161

FJSRL-TR-77-0011

A SURVEY OF LEAD LEVELS IN SOILS AND VEGETATION
OF SELECTED AIRFIELD ENVIRONMENTS

By

Major Charles E. Thalken
Capt Alvin L. Young
Captain Michael J. Moran
Lt Col Lawrence R. Klinestiver

6/10/24
October 1977

Department of Chemistry and Biological Sciences
US Air Force Academy, CO 80840

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER FJSRL-TR-77-0011✓	2. GOVT ACCESSION NO. AC-	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) A Survey of Lead Levels in Soils and Vegetation of Selected Airfield Environments		5. TYPE OF REPORT & PERIOD COVERED Summary Report
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Charles E. Thalken, Maj, USAF, VC, DVM Alvin L. Young, Capt, USAF, PhD Michael J. Moran, Capt, USAF, PhD Lawrence R. Klinestiver, LtCol, USAF, PhD		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Department of Chemistry and Biological Sciences ✓ DFCBS-R USAF Academy, Colorado 80840		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Frank J. Seiler Research Laboratory ✓ AFSC USAF Academy, Colorado 80840		12. REPORT DATE October 1977
		13. NUMBER OF PAGES
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report)
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) For Official Use Only		
<div style="border: 1px solid black; padding: 5px; text-align: center;"> DISTRIBUTION STATEMENT A Approved for public release; Distribution Unlimited </div>		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Lead Soils Vegetation Military Airport Environments		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) Soil and vegetation from a control area and from areas immediately adjacent to the airfields at USAF Academy and Peterson AFB, CO, were analyzed for elemental lead using a Model 403 Perkin-Elmer Atomic Absorption Spectrophotometer. Mean lead levels in soil of 2.4, 10.2, and 6.2 ppm were found for the three locations, respectively. Mean lead levels in vegetation of 3.4, 25.4, and 40.4 ppm were found for the three locations, respectively. These data suggest the need for studies of indigenous herbivores for possible lead accumulation.		

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

TABLE OF CONTENTS

<u>SECTION</u>	<u>PAGE</u>
INTRODUCTION	1
METHODS AND MATERIALS	4
Sampling Dates	4
Sampling Protocol	4
Preparation and Analysis of Samples	4
RESULTS AND DISCUSSION	8
BIBLIOGRAPHY	16

ACCESSION FOR		
NTIS	White Section	<input checked="" type="checkbox"/>
DOC	Off Section	<input type="checkbox"/>
CHANDLER		<input type="checkbox"/>
AUTHORITY		
<i>Letter on file</i>		
BY		
DISTRIBUTION/AVAILABILITY CODES		
Doc.	AVAIL. DOC. OF SPECIAL	
A		

LIST OF FIGURES

<u>FIGURE</u>	<u>PAGE</u>
1 Square-foot Analysis Technique Used for Vegetative Assessment and for Collection of Plant and Soil Samples . .	5
2 Beer's Law Plot of Standard Solutions of Elemental Lead as Determined by Atomic Absorption Spectrophotometer .	7
3 Looking North from South End of Northwest-Southeast Runway (Sampling Station E-5), Peterson AFB, Colorado . . .	10
4 Typical Vegetation Adjacent to the Air Force Academy Airport. Vegetative Composition Includes Blue Grama, Crested Wheatgrass, Sand Dropseed, Fringed Sagebrush, and Hairy Golden Aster	11
5 Typical Vegetation Adjacent to the Peterson AFB Airport. Vegetative Composition Includes Blue Grama, Crested Wheatgrass, Needle-and-Thread Grass, Fringed Sagebrush, and Green Sagebrush	11

LIST OF TABLES

<u>TABLE</u>		<u>PAGE</u>
1	Number of Joint Aircraft Operations at Peterson AFB and Colorado Springs Municipal Airport for 1973	9
2	Number of Military (Training) Operations at the USAF Academy Airport for 1976	9
3	Levels of Lead (PPM) in Soils and Vegetation from the USAF Academy Airport. Samples Collected May 1976. . . .	12
4	Levels of Lead (PPM) in Soils and Vegetation from Peterson Air Force Base. Samples Collected August 1976	13

INTRODUCTION

Lead is a soft insoluble heavy metal that occurs naturally in air, soils, water and biological tissue. Among the natural sources of lead in the atmosphere are silicate dusts, volcanic smoke and smoke from forest fires (10). The combustion of fossil fuels contributes approximately 4 percent of atmospheric lead (4). The United States is the major lead consuming country in the world with automobile manufacturing comprising the largest industrial use of lead. Use of lead in gasoline antiknock additives is second and accounts for 21 percent of all lead used in the United States (13).

It is generally accepted that the world's mean soil concentration of lead is 16 parts per million (ppm) (4). Cannon and Swanson (3) indicated that 20 ppm was the mean lead level for soils in the United States. Berry et al. (2) reported that, in general, lead levels in rural areas ranged from 10-15 ppm while levels in urban and industrial areas ranged from 17 to 12,000 ppm. Seeley et al. (11) found that in studies of soil profiles, lead levels were greatest in surface increments with decreasing concentrations at lower increments. Arvik et al. (1) suggested that lead may form an insoluble complex in soils, thus restricting its movement in a soil profile.

Although lead is not considered an essential trace element in plants, significant concentrations have been reported in plants from urban areas (5), along highways (8), and near smelters and foundries (6). Motto et al. (9) reported lead levels in plant tissue of 5-10 ppm for rural areas, while Goodman and Roberts (6) reported levels of 45-500 ppm in

vegetation growing near a smelter operation. Ter Harr (12) concluded that translocation of lead occurred in both leaves and roots; however, the root was the major organ for uptake and storage of lead. Thus, lead burden in vegetative tissues should be determined by examination of the entire plant, i.e., roots, stems and foliage. Factors that influenced lead uptake in plants included soil pH, organic matter, soil moisture and climatic effects (7). Moreover, Ter Harr (12) found that a genetic component may also exist in plants which may influence affinity for lead.

Although there is abundant literature on environmental levels of lead generated from many urban and industrial activities, no data are apparently available on levels of lead in and around military or commercial airports. The Air Installation Compatible Use Zone, AICUZ, is a concept designed to provide air bases and airports with environmental impact zoning districts. These zones encompass areas of significant accident potential and noise impact. However, data are needed to extend the concept to include determinations of environmental quality on and around air installations. Many airports, e.g., Peterson AFB, Colorado Springs, Colorado, have a long history of continuous use by both reciprocating and jet aircraft, yet no data are available as to the concentrations of lead generated by aircraft engines. Nevertheless, the flight approach paths to many airports, including those at Peterson AFB, are routinely used for agricultural activities. Concentrations of lead in vegetation and soils are not known in these environments. As more stringent environmental qualities and standards are applied by

the Environmental Protection Agency, it becomes essential that the Air Force develop monitoring programs to measure levels of environmental pollutants around air installations.

...

...

...

METHODS AND MATERIALS

Sampling Dates

Soils and vegetation were collected from the USAF Academy and Peterson AFB airports in May and August 1976, respectively. Control samples were collected near the southwest corner (upper Horse Pasture, Pine Valley) of the Air Force Academy in April 1976.

Sampling Protocol

Using a square-foot quadrat, five 0.093 m^2 sites were randomly selected within each of the 10 designated study areas (1 control, 4 USAF Academy and 5 Peterson AFB study areas). Figure 1 illustrates the use of a square-foot quadrat. All vegetation within the quadrat was removed by clipping at the surface level and placed in a paper bag. For each study area, grasses, broad leaves, and shrubs (for five quadrats) were placed in separate bags. Soil samples for each of the five quadrats were taken following the removal of the vegetation and also placed in paper bags. The soil samples were collected, using a porcelain spatula, in 3 cm increments to a depth of either 6 cm (USAF Academy and control) or 9 cm (Peterson AFB). Soil samples were combined by depth and thoroughly mixed for each study area.

Preparation and Analysis of Samples

All samples were dried in a laboratory oven at 50°C for 2 weeks, after which the vegetative samples were ground in a Wiley Mill to pass a 40-mesh screen. One gm samples of vegetation and 5 gm samples of soil were weighed on an analytical balance to the nearest 0.001 gm.



FIGURE 1. SQUARE-FOOT ANALYSIS TECHNIQUE USED FOR VEGETATIVE ASSESSMENT AND FOR COLLECTION OF PLANT AND SOIL SAMPLES.

Samples were transferred to 125 ml erlenmeyer flasks and 20 ml of 50:50 (v/v) concentrated nitric acid and concentrated hydrochloric acid were added to each flask. The flasks were covered with two layers of parafilm and placed in a water bath at 50°C for 1 week. The samples were shaken frequently each day to assure complete mixing and dissolution. The samples were allowed to cool to room temperature and filtered through a Whatman Number 541 filter paper. The flasks and filter apparatus were washed with glass distilled water and the washings added to the filtrate. The samples were stored in plastic bottles at room temperature until analyzed by atomic absorption spectroscopy.

All samples were analyzed using a Perkin Elmer Atomic Absorption Spectrophotometer Model 403. The parameters for the analysis were:

Source:	Hollow Cathode Lead Lamp
Flame:	Air-Acetylene
Wave Length:	283.3 nm - UV
Slit:	4 (0.7 nm)
Function:	Absorbance
Mode:	Peak

Analytical standards were prepared by first dissolving 0.1598 gm of high purity lead nitrate in 20 ml to 100 ml glass distilled water. This resulted in a stock solution of 1000 µg/ml. Dilutions of the stock solution were prepared to make analysis samples of 1, 3, 5, 7, 10, 12, 15 and 20 µg/ml. The Beer's Law plot of these solutions is shown in Figure 2. Each of the test samples were run several times with the standard solutions and the average results recorded.

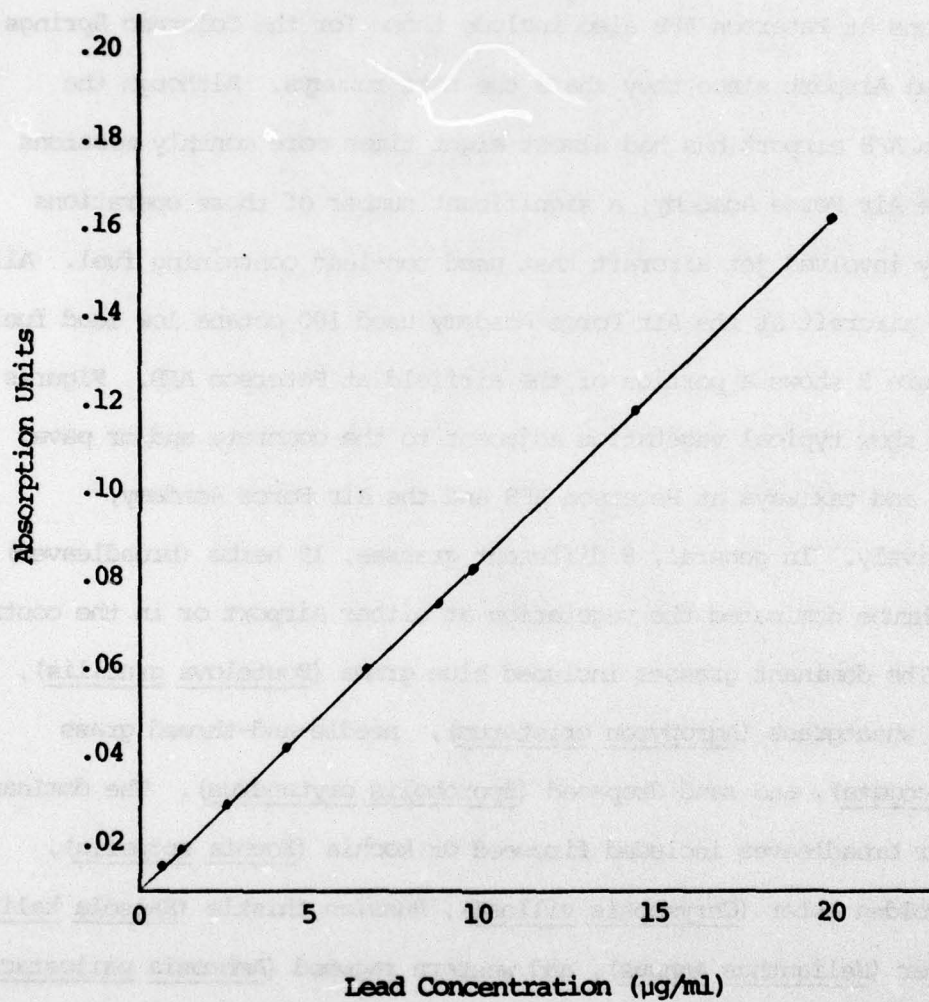


FIGURE 2. BEER'S LAW PLOT OF STANDARD SOLUTIONS OF ELEMENTAL LEAD AS DETERMINED BY ATOMIC ABSORPTION SPECTROPHOTOMETER

RESULTS AND DISCUSSION

Comparisons of aircraft use, i.e., the number of individual aircraft operations or sorties, for Peterson AFB and the USAF Academy airports, are shown in Tables 1 and 2, respectively. The number of aircraft operations at Peterson AFB also include those for the Colorado Springs Municipal Airport since they share the same runways. Although the Peterson AFB airport has had almost eight times more monthly missions than the Air Force Academy, a significant number of those operations probably involved jet aircraft that used non-lead containing fuel. All of the aircraft at the Air Force Academy used 100 octane low lead fuel.

Figure 3 shows a portion of the airfield at Peterson AFB. Figures 4 and 5 show typical vegetation adjacent to the concrete and/or paved runways and taxiways at Peterson AFB and the Air Force Academy, respectively. In general, 8 different grasses, 19 herbs (broadleaves) and 2 shrubs dominated the vegetation at either airport or in the control area. The dominant grasses included blue grama (Bouteloua gracilis), crested wheatgrass (Agropyron cristatum), needle-and-thread grass (Stipa comata), and sand dropseed (Sporobolis crytandrus). The dominant herbs or broadleaves included fireweed or kochia (Kochia scoparia), hairy golden aster (Chrysopsis villosa), Russian thistle (Salsola kali), sunflower (Helianthus annuus), and western ragweed (Ambrosia psilostachya). The two shrubs common to all study areas were fringed sagebrush (Artemisia frigida) and green sagebrush (Artemisia canadensis).

Levels of lead, ppm, for soil and vegetation from all sites for each study area are shown in Tables 3 and 4. It should be noted that

TABLE 1. NUMBER OF JOINT AIRCRAFT OPERATIONS AT PETERSON AFB
AND COLORADO SPRINGS MUNICIPAL AIRPORT FOR 1973*

<u>TYPE</u>	<u>NUMBER OF OPERATIONS</u>	<u>AVERAGE PER MONTH</u>
Air Carrier Operations	20,746	1,728
General Aviation Operations	101,663	8,472
Military Operations	86,751	7,230
Total	209,160	17,430

*Source: "Environmental Impact Assessment Report for
The Proposed Master Plan Development at Colorado
Springs Municipal Airport, Colorado Springs, Colorado,"
October 1974, Prepared by Isbill Associates, Inc.,
Airport Consultants and Engineers, Stapleton Inter-
national Airport, Denver, CO 80207

TABLE 2. NUMBER OF MILITARY (TRAINING) OPERATIONS
AT THE USAF ACADEMY AIRPORT FOR 1976*

<u>TRAINING PROGRAM</u>	<u>AIRCRAFT</u>	<u>NUMBER OF OPERATIONS</u>	<u>AVERAGE PER MONTH</u>
Pilot Indoctrination	T-41	13,000	1,083
Soaring	Piper Super Cub	13,500	1,125
Parachute Free Fall	U-4	1,780	148
Total		28,280	2,356

*Source: Airmanship Division, USAF Academy, CO 80840

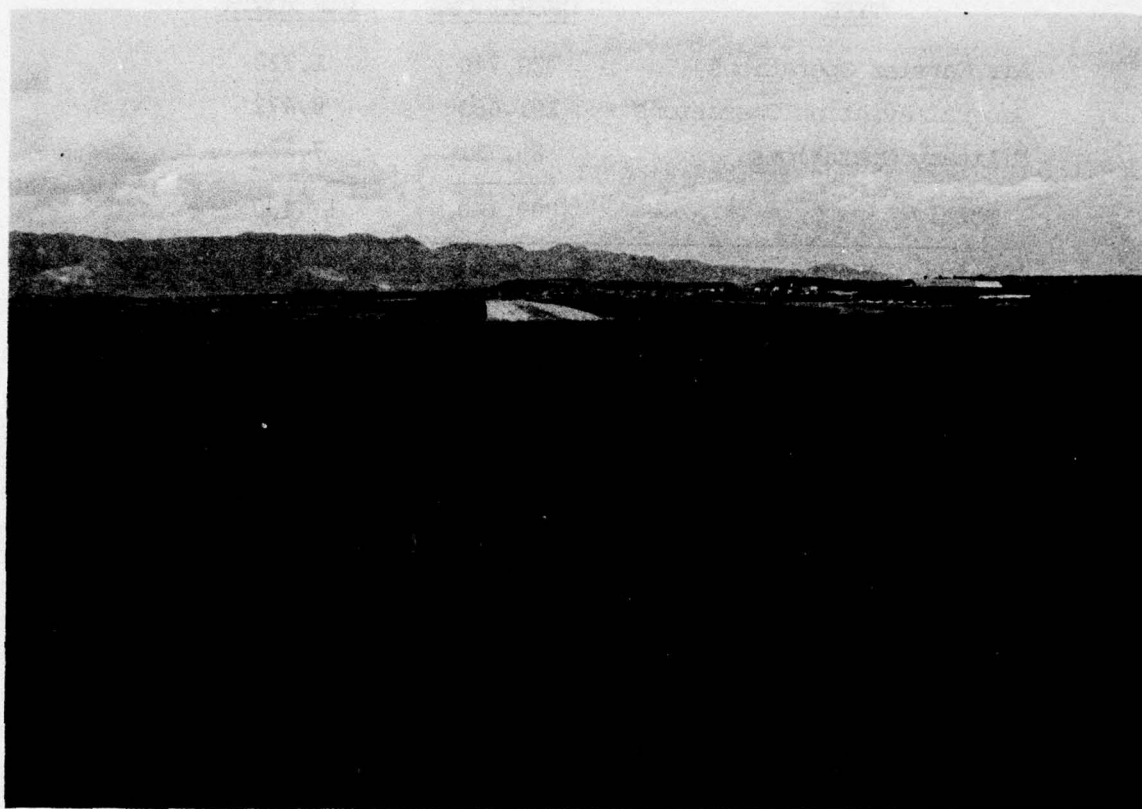


FIGURE 3. LOOKING NORTH FROM SOUTH END OF NORTHWEST-SOUTHEAST
RUNWAY (SAMPLING STATION E-5), PETERSON AFB, COLORADO



FIGURE 4. TYPICAL VEGETATION ADJACENT TO THE AIR FORCE ACADEMY AIRPORT. VEGETATIVE COMPOSITION INCLUDES BLUE GRAMA, CRESTED WHEATGRASS, SAND DROPSEED, FRINGED SAGEBRUSH, AND HAIRY GOLDEN ASTER.



FIGURE 5. TYPICAL VEGETATION ADJACENT TO THE PETERSON AFB AIRPORT. VEGETATIVE COMPOSITION INCLUDES BLUE GRAMA, CRESTED WHEATGRASS, NEEDLE-AND-THREAD GRASS, FRINGED SAGEBRUSH, AND GREEN SAGEBRUSH.

TABLE 3. LEVELS OF LEAD (PPM) IN SOILS AND VEGETATION
FROM THE USAF ACADEMY AIRPORT. SAMPLES COLLECTED
MAY 1976.

COLLECTION SITE	SOILS		VEGETATION	
	0-3 CM	3-6 CM	SAGEBRUSH ^a	GRASS ^b
East of New Runway (Midway)	10.0	16.0	10	30
East of Old Runway (Midway)	12.6	11.2	30	ND ^c
North End of Old Runway (Overrun)	10.4	11.2	29	29
South End of Old Runway	10.3	10.0	30	30
Control	2.2	2.6	4.5	2.3

^a Artemisia frigida (Fringed Sagebrush)

^b Composite samples of Agropyron cristatum (crested wheatgrass) and
Boutelova gracilis (blue grama)

^c Not determined

TABLE 4. LEVELS OF LEAD (PPM) IN SOILS AND VEGETATION FROM
PETERSON AIR FORCE BASE. SAMPLES COLLECTED AUGUST 1976.

COLLECTION SITE	SOILS		VEGETATION	
	0-3 CM	3-6 CM	BROADLEAVES ^a	GRASSES ^b
Area Adjacent to Spanish House Recreational Center (E-1)	4.3	2.8	11.5	60.0
Area Adjacent to Baseball Field (E-2)	1.9	0.9	60.0	40.0
Area Adjacent to Taxi- way near Base Opera- tions (E-3)	5.9	4.7	40.0	42.5
Area Between N-S and N-W Runways (E-4)	15.5	14.0	47.0	40.0
Overrun at South End of N-W/S-E Runway (E-5)	9.8	5.9	1.0	22.5

^aComposite samples of Salsola kali (Russian Thistle), Ambrosia psilostachya (Western Ragweed), and Chrysopsis villosa (Hairy Golden Aster)

^bComposite samples of Agropyron crestatum (Crested Wheatgrass), Bouteloua gracilis (Blue Grama), and Sporobolus crytandrus (Sand Dropseed)

all values represented the mean of duplicate or triplicate analyses of each sample.

Soils from the control and Air Force Academy study areas generally contained more lead in the lower increment (3-6 cm) than in the surface increment (0-3 cm). This, however, was not true of the soil samples collected at Peterson AFB; the greatest concentrations of lead were found in the surface increment.

From Table 3, for the Air Force Academy, there was no apparent correlation of lead levels in soil with the age of the runway. Although the new runway was constructed in 1974, samples collected near it had lead levels comparable to those samples collected near the old runway. Vegetative samples from the same areas were similar but contained approximately twice the levels of lead as were found in soils.

In Table 4, the collection sites and soil level of lead corresponded with the distance from the flight line. The Spanish House Recreational Center and the baseball field were approximately one-half mile from the flight line and thus had the lowest concentrations of lead. In addition, the baseball field had recently received additional top soil. The data supported this field observation. The highest soil concentration of lead was found between the active runways. The concentration of lead was 15.5 ppm in the top 3 cm increment and decreased only slightly with depth. This suggested that lead did move in the soil profile. Additional sampling would be required to determine the depth and magnitude of this movement.

In general, the vegetation at Peterson AFB airport, Table 4,

accumulated greater levels of lead than were present in the soils. The one exception to this was samples collected at the south end of the northwest-southeast runway (site E-5). This area had been recently reseeded. Whether or not this influenced the lead concentrations in the plants was not determined.

In conclusion, the data indicated that lead has accumulated in soils and plants adjacent to the airports at Peterson AFB and USAF Academy. The magnitude of this accumulation, however, is within the range found in soils and vegetation along highways and near industrial sites. The data support continued studies of the respective airports, and especially studies of indigenous herbivores for possible lead accumulation.

BIBLIOGRAPHY

1. Arvik, J.H., R.L. Zimdahl, K.W. Olson, D. Dick, and R.K. Skogerboe. 1973. An apparatus for the exposure of plants to selected particulate aerosols. *Rev. Sci. Instrum.* 44(7):800-802.
2. Berry, J.W., D. Osgood, and P.A. St. John. 1974. *Chemical villains: a biology of pollution.* C.V. Mosby Co., St Louis, MO, 431 pp.
3. Cannon, H.L. and B.M. Anderson. 1972. Trace element content of the Four Corners power plant. Coal Resources Work Group, Southwest Energy Study, Appendix J-III, US Geological Survey.
4. Chow, T.J. and J.L. Earl. 1970. Lead aerosols in the atmosphere: increasing concentrations. *Science* 169:577-580.
5. DeTreville, R.T.P. 1964. Natural occurrence of lead. *Arch. Environ. Health* 8:212-221.
6. Goodman, G.T. and T.M. Roberts. 1971. Plants and soils as indicators of metals. *Nature* 231:287-292.
7. Kehoe, R.A. 1964. Metabolism of lead under abnormal conditions. *Arch. Environ. Health* 8:225-243.
8. Lagerwerff, J.V. and A.W. Sprecht. 1970. Contamination of road-side soil and vegetation with cadmium, lead, and zinc. *Environ. Sci. Tech.* 4:583-586.
9. Motto, H.L., R.H. Daines, D.M. Chilko, and C.K. Motto. 1970. Lead in soils and plants: its relationship to traffic volume and proximity to highways. *Environ. Sci. Tech.* 4:231-237.
10. Patterson, C.C. 1965. Contaminated and natural lead environments of man. *Arch. Environ. Health* 11:344-360.
11. Seeley, J.L., D. Dick, J.H. Arvik, R.L. Zimdahl, and R.K. Skogerboe. 1972. Determination of lead in soil. *Appl. Spectrosc.* 26(4): 456-460.
12. Ter Harr, G.L. 1970. Air as a source of lead in edible crops. *Environ. Sci. Tech.* 4:226-229.
13. Welch, W.R. 1972. Lead concentrations in tissues of road mice. Thesis. Department of Zoology, Colorado State University, Fort Collins, CO.